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भारतीय मानक

विलायक युक्त विद्युतरोधी वार्निश

भाग 2 परीक्षा पद्धति

(पहला पुनरीक्षण)

Indian Standard

INSULATING VARNISHES CONTAINING SOLVENTS

PART 2 METHODS OF TESTS

(First Revision)

ICS 29.035.99:87.040

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 6

Solid Electrical Insulating Materials Sectional Committee, ETD 02

FOREWORD

This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Solid Electrical Insulating Materials Sectional Committee had been approved by the Electrotechnical Division Council.

This standard (Part 2) is one of the series of Indian Standards which deals with insulating varnishes containing solvents, methods of tests.

The series comprises the following three parts:

Part 1 Definitions and general requirements,

Part 2 Methods of tests, and

Part 3 Specifications for individual materials.

This standard (Part 2) covers the methods of tests applicable to insulating varnishes containing solvents for use in electrical equipment.

In preparing this standard assistance has been derived from IEC Publication 464-2 (1986) 'Specification for insulating varnishes containing solvent — Part 2 : Methods of tests', issued by the International Electrotechnical Commission (IEC).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

INSULATING VARNISHES CONTAINING SOLVENTS

PART 2 METHODS OF TESTS

(First Revision)

1 SCOPE

1.1 This standard (Part 2) covers the methods of tests applicable to insulating varnishes containing solvents for use in electrical equipment.

1.2 Test methods for varnishes as supplied are covered under Section 1 and test method for varnishes in the cured form are covered in Section 2.

SECTION 1 TEST METHODS FOR VARNISHES AS SUPPLIED

2 REFERENCES

The referred Indian Standards are given in Annex A.

3 SAMPLING

3.1 The samples shall be submitted packed in three different containers, each containing not less than one litre of the material.

3.2 Representative samples of the material shall be drawn as prescribed in IS 197.

4 DENSITY

The density of the varnish can be determined by weighing a sample of varnish in a 25 cm^2 (minimum) capacity, wide-mouthed pycnometer, at 27 ± 2°C to the nearest 5 mg and dividing the mass of varnish by the mass of an equal of distilled water at the same temperature.

The density can also be determined with a hydrometer; in case of dispute, a pycnometer shall be used. Report the result in g/cm^2.

5 VISCOSITY

The viscosity at 27 ± 2°C shall be determined with a suitable viscometer. The tolerance of ±2°C on the temperature is the normal tolerance. If a higher accuracy is needed, the tolerance shall be ±0.5°C. The viscometer used shall be kept calibrated over the range of viscosity of the varnishes to be tested by means of oils verified as to dynamic viscosity at 27°C. A calibration curve showing the relation between viscosity in centipoises and the instrument reading shall be used.

Efflux type viscometers may be used to determine viscosity of the varnish. When flow cups are used, the type and the method of test shall be as specified in **7.4.1** of IS 101 using flow cup in accordance with IS 3944.

All disputes shall be resolved using calibrated viscometers to measure the viscosity in centipoises.

6 NON-VOLATILE MATTER

To be determined according to IS 101 (Part 2/Sec 2).

The following particulars should be noted.

Before the determination, the drying dish shall have been heated for 30 min at 135°C.

The mass of the specimen shall be between 1.5 g and 2.0 g.

Three specimens shall be prepared.

The specimens are placed in the oven within 30 min after preparation and heated for 2 h at 135-140°C or as agreed between the supplier and the purchaser.

The central value of the three results obtained is the percentage non-volatile matter.

7 DRYING TIME IN THIN FILMS

7.1 Apparatus

Metal panels cold rolled carbon sheet to IS 513 approximately 100 mm in length and 100 mm in width and 0.125 ± 0.010 mm to 0.200 ± 0.10 mm in thickness, wiped clean and dry (*see* Note).

Soft rubber disks with a diameter of 20 mm and a thickness of 5 mm.

Cylindrical weight with a mass of 500 g and a contact surface with a diameter of 20 mm.

Filter paper.

NOTE — Cleaning can be effected by treating with a suitable solvent (toluene-ethanol 1:1 or xylene-ethanol 1:1). Then, polish thoroughly with No. 000 steel wool and finally wipe free of any finger prints or metal particles with the solvent and a lint free cloth. If the panels are not to be used immediately, they shall be kept stored in a non-corrosive solvent.

7.2 Procedure

Cover the panels at a temperature of 27 ± 2°C with a layer of varnish that results in a final thickness as prescribed in Part 3 of this standard. The covering may be applied by dipping, spraying or any suitable method. When specimens are prepared by dipping, the viscosity of the varnish shall be as specified by the supplier. If necessary, the varnish is diluted to a suitable consistency. In any case, the specimens shall be allowed to stand immersed until free of air bubbles.

Suspend for drying in dust free air at the temperature and for the time designated in Part 3 of this standard. After drying, the specimens are examined at a temperature of 27 ± 2°C. A piece of filter paper is placed on the panel and the weight is placed on the paper in the vicinity of the centre of the specimen, with the rubber disk interposed between the paper and the weight to distribute the pressure equally. After 1 min the weight and the disk are removed and the specimen is examined.

The paper falls off the specimen under its own weight with slight vibration, no paper fibres are left on the specimen.

Result: Non-tacky.

NOTE — It may happen that the paper adheres under its own weight even when slightly vibrated. In this case, one should try by touching it gently. If it can be removed, it should be considered as non-tacky, provided that no paper fibres are left.

The paper sticks to the specimen; when the filter paper is torn off, a significant amount of paper fibres remains on the specimen.

Result: Non-tacky.

7.3 Results

Report the test condition and the result 'tacky' or 'non-tacky'.

7.4 Preparation of Specimen for Core Plate Varnish

Cover the panels at a temperature 27 ± 2°C with two coats of varnish that result in average thickness of 0.010 mm on each side. The covering may be applied by dipping, spraying or any suitable method. When the specimens are prepared by dipping, the viscosity of the varnish shall be specified by the supplier. If necessary, the varnish shall be diluted to a suitable consistency.

8 FLASH POINT

The flash point of the varnish is determined within the limits of the instrument used for the temperature range 5 to 65°C.

8.1 Apparatus

Any of the closed-cup apparatus listed in IS 197 may be used to determine the flash point of varnish.

8.2 Procedure

The method whereby the flash point of varnish is determined, is that specified in **13** of IS 197 except that no stirring is used.

8.3 Results

The test report shall state:

a) identification of the varnish tested,

b) exact description of the test instrument used, and

c) flash point calculated as in **13** of IS 197.

9 DILUTION ABILITY OR COMPATIBILITY

9.1 Apparatus

A 100 cm^3 stoppered measuring cylinder graduated in cm^3.

9.2 Procedure

20 cm^3 of the filtered varnish is poured into the stoppered measuring cylinder 10 cm^3 of the thinner described by the supplier is added; after shaking vigorously, the mixture is allowed to rest for some minutes. If no cloudiness or separation is observed, 5 cm^3 of the thinner is added and the cylinder is shaken again and allowed to rest. This is repeated until the mixture becomes cloudy or separation is observed.

9.3 Results

The test report shall state:

a) identification of the varnish tested,

b) nature of the thinner,

c) percentage in volume of thinner that can be added before the first turbidity appears, and

d) temperature.

10 ABILITY TO CURE IN CONSIDERABLE THICKNESS

10.1 Apparatus

- Flat pieces of aluminium foils, 0.1 mm thick of about 95 mm 95 mm.
- Steel former with a base area of 45 mm 45 mm and a height of 25 mm.
- Cylindrical weight with a mass of 500 g and a contact surface with a diameter of 20 mm.
- Soft rubber disks with a diameter of 20 mm and a thickness of 5 mm.

- — Filter paper.
- — Laboratory drying oven with automatic temperature regulation. The air content of the oven should be replaced at least three times per hour.

10.2 Procedure

Two specimens are necessary for this test. From the square aluminium foils, fold two small boxes having a base area of 45 mm 45 mm and a height of 25 mm by bending the foil round the former. The aluminium foil has to be cleaned with a mixture of xylene and anhydrous ethanol before being used. The varnish to be tested is weighed to 0.1 g in boxes so prepared, the quantity being dependent on the content of non-volatile matter according to Table 1.

Table 1 Quantity of Varnish Required for Ability to Cure Test

Sl No.	Contents of Non-volatile Matter in Varnish Tested, Percent	Mass g
(1)	(2)	(3)
i)	40	25.0
ii)	42	23.8
iii)	44	22.7
iv)	46	21.7
v)	48	20.8
vi)	50	20.0
vii)	52	19.2
viii)	54	18.5
ix)	56	17.9
x)	58	17.2
xi)	60	16.7

After drying, the thickness of the resulting gel layer is about 4 mm. The boxes are placed in the drying oven. The drying conditions, temperature and time are stated in the standard or specification for the insulating varnishes, or as recommended by the supplier of the varnishes.

After the withdrawal from the drying oven, the specimen should be cooled under standard laboratory conditions. The side walls and the underside of the aluminium boxes are removed by bending them back.

Afterwords the specimens freed from the foil are conditioned for 16 h at a temperature of 27 ± 2°C and a relative humidity of 50 ± 5 percent.

10.3 Evaluation

The varnish residue (gel), formed in the boxes, should be assessed:

a) by its condition on the upperside (S) (*see* Table 2),

b) by its condition on the underside (U) (*see* Table 3),

(c) by its condition in the interior (I) (*see* Table 4).

according to the following statements for a visual appearance.

Table 2 Condition of the Upperside

(*Clause* 10.3)

Condition of the Upperside of the Specimen	Symbols	
	Identity Letter	Identity Figure
(1)	(2)	(3)
Upperside	S	
Smooth		1
Wrinkled		2

Table 3 Condition of the Underside

(*Clause* 10.3)

Condition of the Underside of the Specimen	Symbols	
	Identity Letter	Identity Figure
(1)	(2)	(3)
Underside	U	
Non-tacky		1
Tacky		2

In order to find out the tackiness of the specimen, the following test should be made:

> On each specimen, whose underside is turned up, a piece of filter paper is placed. The paper is loaded for 1 min with the cylindrical weight. A rubber disk is placed between the weight and the piece of paper. After 1 min, the weight is removed and the specimen is examined in accordance with **7.2**.

Table 4 Condition of the Interior

(*Clause* 10.3)

Condition of the Interior of the Specimen	Identity Letter	Symbols	
		Identity Figure	
		First	Second
(1)	(2)	(3)	(4)
Interior	I		
Brittle-hard		1	
Horny machinable		2	
Leather like rigid		3	
Soft rubber like		4	
Gel like		5	
Liquid		6	
Free of bubbles			.1
Few bubbles			.2
Bubbly			.3

A statement whether the interior is almost 'uniform' or 'not uniform' is made by adding the relevant term to the symbol or to the test, for example "I 3.1 uniform 'or' interior leatherlike rigid, free of bubbles, uniform".

Bending the specimen with the fingers sometimes helps judging the mechanical properties (brittleness, softness, etc); it may be necessary to cut the specimen to examine the interior.

10.4 Test Report

In the test report, the results of the visual examination of the two specimens and the result of the tackiness examination of the underside should be indicated by means of the following symbols, for example:

Condition of upperside: S1

Condition of underside: U2

Condition of interior : I 4.1 uniform

If the results of the two specimens differ, additional specimens should be tested.

11 CHECK FOR RESOFTENING

11.1 Procedure

Allow one of the samples prepared as in **10.2** containing the dried material to stand on its edge for one hour in laboratory drying in an oven in which the temperature is 10°C above the temperature index of the varnish stated by the supplier. Allow the sample to cool at a temperature of 27 ± 2°C.

11.2 Evaluation

The condition of the varnish specimen in troughs is evaluated visually and by touch as given in Table 5.

Table 5 Evaluation of Resoftening of the Varnish Specimen

(*Clause* 11.2)

Condition of Varnish Specimen	Symbol	
	Identity Letter	Identity Figure
(1)	(2)	(3)
Shape of specimen	W	—
No change in shape	—	1
Slight change in shape or slight softening	—	2
Heavy softening of coagulation	—	3

11.3 Test Report

In the test report, the visual examination of the specimen shall be indicated by means of the following symbols:

Conditions after resoftening for slight change in shape of specimen W,2

12 REACTION OF VARNISH WITH COPPER

12.1 Apparatus

36 pieces of copper wire as per IS 13730 (Part 0/ Sec 1) 0.5 mm in diameter, 120 mm in length.

A laboratory drying oven with automatic temperature regulation.

12.2 Procedure

The pieces of copper wire are taped together in three places with cotton tape.

12.3 This bundle of wire is dried for 1 h in an oven at 105°C, then cooled to room temperature in a desiccator and immersed for 10 min in filtered varnish. The varnish is allowed to drain for 5 min and is then dried according to the instructions of the supplier. After cooling, the bundle is immersed again in the varnish repeating the foregoing cycle.

After cooling, the cotton tape is removed and the copper wire is examined. Any change of colour of the copper is reported.

13 STABILITY OF VARNISH IN AN ENCLOSED VESSEL

13.1 Object of the Test

The object of this test is to investigate changes taking place in an impregnating varnish when heated in an enclosed vessel, by measuring differences in viscosity.

Remark: The method cannot be applied to varnishes supplied in more than one component.

13.2 Apparatus

- An oven, 50 litres capacity, with natural ventilation.
- A vessel of 250 cm^3 capacity, made of glass or a neutral metal, with hermetic closure.
- A balance accurate to 0.05 g.
- A viscometer according to **5**.

13.3 Procedure

Measure the viscosity of the varnish under test according to **5**.

Take a sample of about 150 g varnish, place it in the vessel and close the vessel.

Weigh to nearest 0.05 g.

Place the vessel in an oven at 60 ± 2°C, after checking the tightness of the seal.

After 96 h, remove the vessel from the oven, allow it to cool to 27°C and weigh it. No change in mass should be detected, outside the acceptable weighing tolerance of ±0.05 g.

Measure the viscosity according to the method selected.

The test may be carried out using a heating period of 1 week.

13.4 Results

Let A_1 be the viscosity, in centipoises, before heating and A_2 after heating.

The result can be expressed by the formula:

$$\text{Change in viscosity} = \frac{A_2 - A_1}{A_1}$$

13.5 Test Report

The test report shall state:

a) identification of the varnish tested;

b) method used for measuring viscosity;

c) duration of heating;

d) change in viscosity; and

e) additional observations (for example skin formation, formation of jellied lumps, precipitation, etc).

14 STABILITY OF VARNISH IN AN OPEN VESSEL

14.1 Apparatus

An oven, 50 litres capacity, with natural ventilation.

14.2 Procedure

150 g of varnish of known viscosity is weighed to the nearest gram into a 250 cm^3 beaker or similar vessel. The vessel is placed in an oven at 50 ± 2°C for 96 h. Every 24 h, sufficient solvent (by volume) to compensate for that lost by evaporation is added and mixed with the varnish. After 96 h, sufficient solvent to compensate for that lost by evaporation is added, mixed with the varnish and the viscosity at 27°C is measured again.

14.3 Results

As in **13.4**.

14.4 Test Report

As in **13.5**.

15 EFFECT OF VARNISH ON ENAMELLED WIRES (PENCIL HARDNESS)

This test is derived from **12** of IEC Publication 251-1 'Methods of test for winding wires, Part 1: Enamelled round wires'.

15.1 Apparatus

Pencils of various hardnesses.

The pencil hardness series is as follows:

6B	5B	4B	3B	2B	B	HB	H	2H	3H	4H	5H	6H	7H	8H	9H
4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Enamelled wire, unless stated in the specification sheet, the type of enamelled wire shall be agreed upon between the supplier and the user.

15.2 Test Specimens

The straight pieces of enamelled wire, 150 mm in length. The diameter of the enamelled wire generally is 0.8 mm.

15.3 Procedure

The test specimens shall be heated for 10 min at 130°C. A glass cylinder containing sufficient varnish to immerse a substantial portion of the test specimens is used. The temperature of the varnish shall be 60 ± 3°C. The specimens shall be immersed in the varnish for 30 min; the temperature shall be maintained within the specified limits during testing.

After 30 min, the specimens shall be removed from the varnish and the hardness of the film shall be determined as pencil hardness.

The period between removal from the varnish and the test shall not exceed 30 s, otherwise erroneous results may be obtained.

Before each test, the point of the pencil shall be sharpened with a smooth-cut file to form a chisel edge having an angle of 60° symmetrical about the axis of the lead.

The specimen to be tested shall be laid flat on a table and the lead pencil, with the hardness called for in the relevant specification, shall be placed on the surface of the specimen at an angle of 60°. The sharpened edge of the pencil shall be pressed slowly along the surface with a force of approximately 5 N.

Three tests shall be made. The varnish film shall not be removed down to the metal in any one of the three tests. The hardness of the lead pencil which just fails to remove the enamel shall be taken as the hardness index.

NOTE — Aluminium panels can be used when the baking temperature is too high for the use of copper.

15.4 Results

The test report shall state:

a) identification of the varnish tested,

b) central value and individual values of the hardness measurements, and

c) type of enamelled wire.

SECTION 2 TEST METHODS FOR VARNISHES IN THE CURED FORM

16 FLEXIBILITY TESTS

16.1 Mandrel Test

16.1.1 *Apparatus*

a) A constant temperature oven with forced air circulation; the content of the oven shall be replaced not less than 3 times per hour, and

b) A mandrel 3 mm in diameter (Fig. 1, shows a suitable arrangement).

16.1.2 *Test Specimens*

Three test specimens prepared on soft copper panels as described in **7.2** (*see* Note), except that the dimensions of the panels shall be related to the apparatus used.

16.1.3 *Procedure*

After cooling to room temperature in a desiccator, the specimens are inserted, one at a time, into the test fixture and bent in about 1s through 180° around the mandrel. Temperature of test: 27 ± 2°C.

16.1.4 *Results*

Report the results of bending as whether or not the specimens show cracking of the varnish film, detectable by the naked eye.

16.2 Cupping Test (Erichsen Test)

To be performed according to IS 10175

The following particulars are stipulated:

The measuring device shall allow an accuracy of 1 mm. Five test specimens prepared on mild steel panels shall be used.

The procedure for the determination of minimum depth of indentation to cause failure shall be used.

The indentation speed shall be 4 mm/min. The surface of the film shall be inspected continuously, using a lamp to illuminate the film surface.

Discontinue the indentation when visible cracks appear and read the indentation depth on the scale to an accuracy of 1 mm.

Higher values than 6 mm shall not be determined, except for special purposes. Check that the steel plate has not cracked; if it has, the test is discarded and further specimens prepared and examined.

Report the indentation depth readings of the measurements.

17 RESISTANCE TO INSULATING LIQUIDS

17.1 Apparatus

a) A container of insulating liquid, and

b) Metal panels as described in **7.1**.

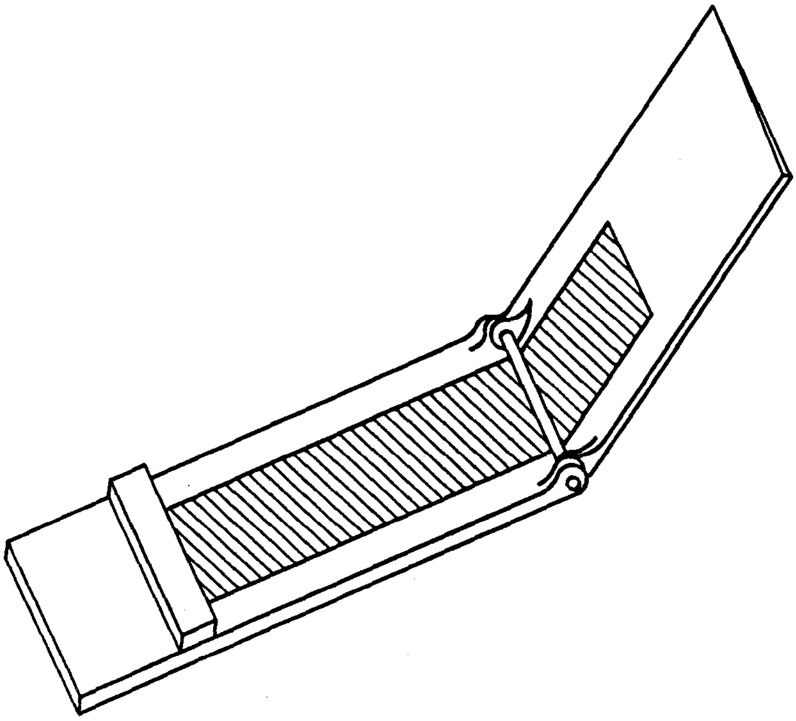

FIG. 1 APPARATUS FOR CARRYING OUT THE FLEXIBILITY TEST

17.2 Test Specimens

Five test specimens prepared by covering the metal panels with a layer of varnish as described in **7.2**.

17.3 Procedure

From one end of the test specimens 10 mm shall be cut away; the cut ends of the specimens shall be immersed in the insulating liquid prescribed at the temperature prescribed for 48 h. The specimens shall be wiped with cotton batting and the effect of the insulating liquid should be based on whether the varnish film dissolved, blistered, wrinkled, loosened or was not physically affected in a visible manner.

17.4 Results

The following shall be interpretted and reported as evidence of attack:

a) Soiling of the cotton batting, which appears due to softened or disintegrated varnish; and

b) Blistering, wrinkling, disintegration or separation of the varnish films.

18 TEST METHOD FOR THE DETERMINATION OF BOND STRENGTH OF IMPREGNATING AGENTS BY TWISTED COIL METHOD

18.1 Principal of the Twisted Coil Test

In this test, 0.315 mm enamelled winding wire in the form of a twisted coil is impregnated and cured. The maximum force to break this specimen is a measure of the bond strength.

18.2 Test Specimen

Prepare a random wound coil from an enamelled winding wire (*see* Note 1) by means of suitable winding equipment [*see* Fig. 3(a)]. To prevent opening of the coil after removal from the winding equipment, each of the winding wire, or short pieces of enamelled wire may be wrapped around the coil two or three times in opposite directions. For this purpose the winding equipment is provided with appropriate notches [*see* Fig. 3(b)]. For winding the coil, the following dimensions apply:

Winding diameter	57 ± 1 mm
Width of slot	6 ± 1.0 mm
Number of turns	100 (*see* Note 2)
Nominals wire diameter	0.315 mm

NOTES

1 For enamelled winding wires, *see also* IS 13730 (Part 0/Sec 1).

2 Instead of 100 turns, two times 50 turns may be used to provide a bifiler winding that allows a.c. current heating of the coil, if desired.

Remove the coil from the winding equipment and stretch it into an oval shape. Twist the coil two full turns around its longitudinal axis by means of a twisting device [*see* Fig. 2(a) and 2(b)]. The twisted coil formed is about 7 mm in diameter and 85 to 90 mm in length and serves as a substrate for the impregnating agent.

Unless otherwise agreed, treat the twisted coil once with the impregnating agent, with the twisted coil in the vertical position, immerse it in impregnating agent for 5 ± 1 min (*see* Note). Remove it slowly and uniformly at a maximum rate of 1 mm/s. Drain horizontally for 10-15 min and cure horizontally according to the manufacturer's recommendation or to an agreed schedule. If more then one treatment is to be given, dip, drain and cure the twisted coil vertically, recovering the direction for each subsequent treatment.

Prepare five specimens for each test temperature.

NOTE — Some impregnating agents, such as high viscosity or thixotropic products may require alternative processing methods.

18.3 Test Equipment

Dimensions of the supports of the test equipment shall comply with Fig. 4.

18.4 Test Procedures

With the specimen properly adjusted according to Fig. 4, apply the force F and increase at an even rate to reach the maximum force in about 1 min.

For tests at elevated temperatures (*see* Note 1), a heating cabinet attached to the equipment may be used. Before testing, the test specimen shall be kept in the cabinet at the test temperature for a time just sufficient to ensure that the test specimen reaches this temperature. The central value of five measurements is the bend strength.

NOTES

1 In case of current heating, the test temperature of the test specimen has to be determined by adequate means, for example, thermocouple resistance measurements.

2 Time at the test temperature must be limited to avoid effecting the bond strength.

18.5 Test Report

Report the following:

- Details of the impregnating agent;
- Details of the substrate (type of enamelled winding wire);
- Details of specimen preparation (single or bifiler coil, impregnating details);
- Test temperatures; and

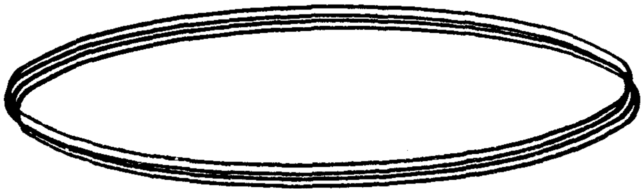

FIG. 2 (a) OVAL SHAPED COIL

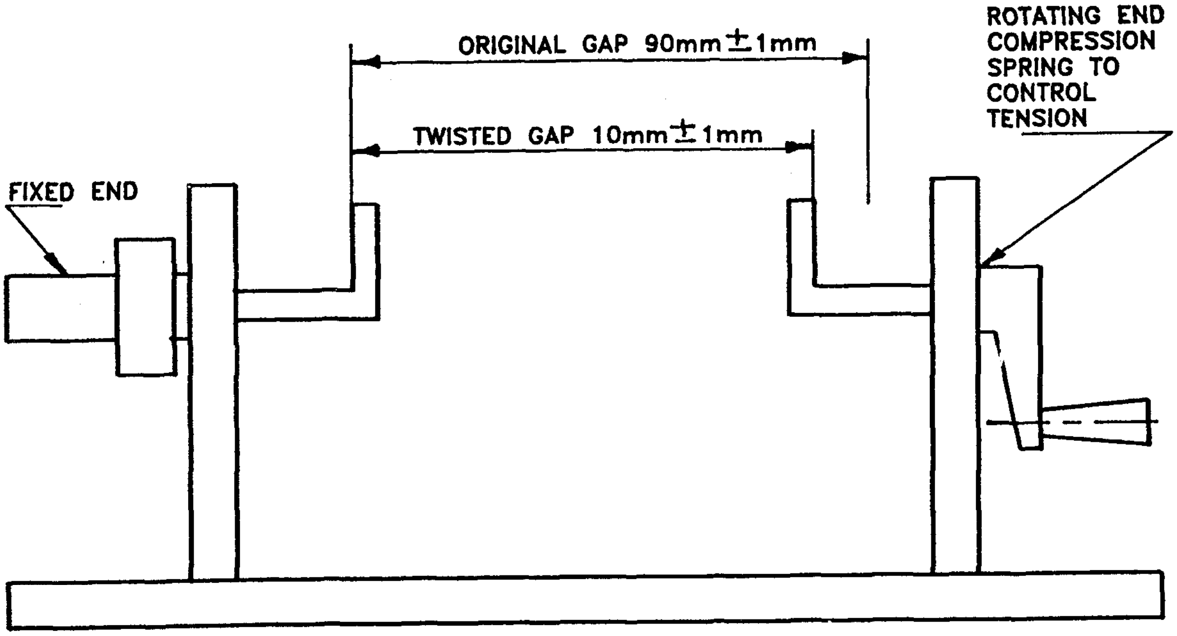

FIG. 2 (b) COIL TWISTER

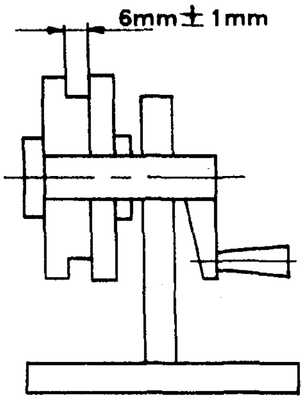

FIG. 3 (a) COIL WINDER

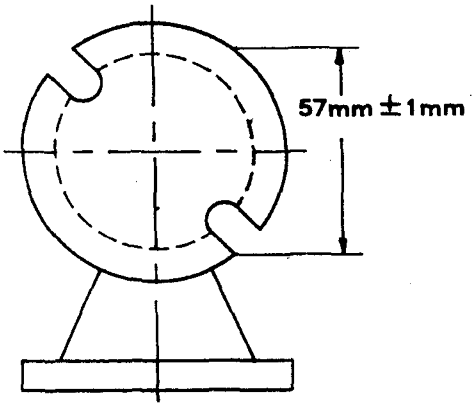

FIG. 3 (b) COIL WINDER, FRONT VIEW

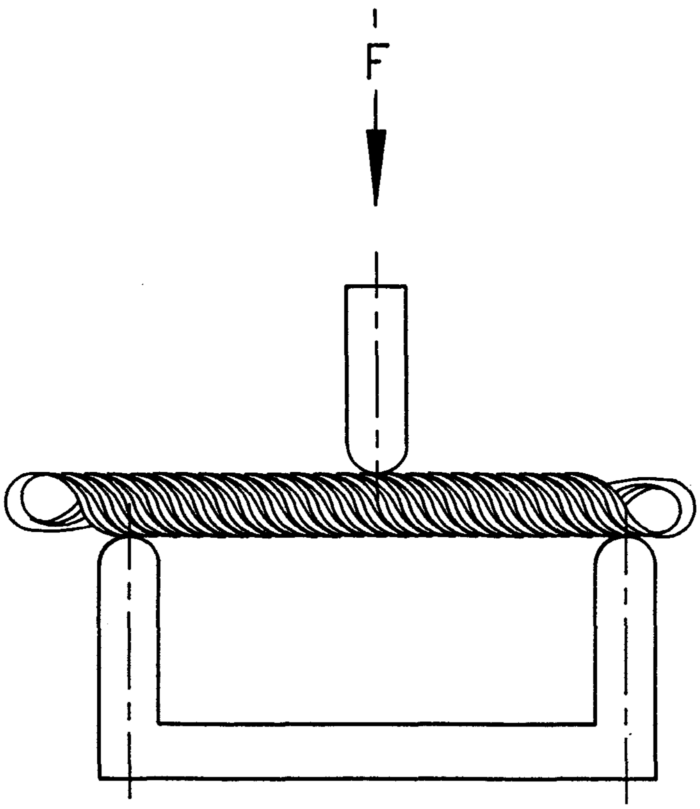

FIG. 4 ARRANGEMENT OF SUPPORTS

- General value and the minimum and maximum values for each test temperatures.

19 VOLUME RESISTIVITY IN AIR AND AFTER IMMERSION IN WATER

19.1 Appearance

The test equipment is that described in IS 3396.

Metal panels 40 mm in width, 100 mm in length, cleaned according to **7.1**.

19.2 Test Specimens

Test specimens shall be prepared by dipping the strips into a tank of the varnish which has been adjusted to the correct viscosity and allowed to stand immersed until free of air bubbles. The correct viscosity of the varnish shall be found by trial when not prescribed. It shall be such that when the strips are dipped in the varnish at a temperature of 27 ± 2°C and are withdrawn slowly and uniformly at the rate of 10 cm/min, the average thickness of the film remaining on each side of a strip when dry shall be on 0.025 mm. The average thickness shall be calculated by averaging at least six measurements taken along the length of the strip and over 3 mm from either edge.

Specimens of air-drying varnish are dried in free air after each dip in the same vertical position in which they were dipped, at 27 ± 2°C and 50 ± 5 percent relative humidity for a period of 24 h unless other conditions are agreed between the buyer and the supplier.

With baking varnishes it may be desirable to allow the specimens to drain at a temperature of 27 ± 2°C until the varnish is set, so that an impression is left by pressing lightly with the finger about 5 cm from the bottom edge. Hereafter, the specimens are baked in the same vertical position in which they were dipped, at the temperature and for the time mentioned in the appropriate specification.

The specimens are given two dips, the viscosity of the varnish shall be readjusted if necessary before the second dip and this dip shall be made in the reverse direction to the first.

As a result of these two dippings on each side of the test specimens a varnish film of 0.050 ± 0.005 mm thickness shall be obtained.

Air-drying varnishes are tested immediately after the specified drying time and baking varnishes are allowed to cool for 15 min at 27 ± 2°C prior to testing.

19.3 Procedure

Three specimens shall be tested.

Test the specimen, using a layer of conducting rubber (maximum resistivity 80 /m) placed between it and the metal electrode, and note the measured insulation resistance from which the volume resistance is calculated.

Immerse in distilled water at 27 ± 2°C for the time indicated by the appropriate specification. Remove and dry with filter paper before repeating the test for resistivity.

19.4 Results

The difference between the two values of the volume resistivity calculated from the available data is the measure of effect of immersion in water.

20 ELECTRIC STRENGTH IN AIR AND AFTER IMMERSION IN WATER AND IN LIQUID CHEMICALS

20.1 Apparatus

a) The equipment for testing electric strength as described in IS 2584.

b) A constant temperature oven with forced air circulation; the air content of the oven shall be replaced not less than 3 times per hour.

20.2 Test Specimens (*see* 19.2)

20.3 Procedure

Test according to IS 2584 using 98 mm dia top and 75 mm dia bottom. The rapidly applied voltage method shall be used.

Five tests are made on one side of the varnished panels, five tests are made on the other side after immersion for 24 h in water at 27 ± 2°C.

In testing specimens after immersion in water, only one specimen should be removed from the water at a time. The specimen after removal from the water should be carefully dried by placing it between sheets of dry blotting paper and pressing down gently with the hand over the entire surface. If necessary, the blotting procedure should be repeated until the specimen is free from surface moisture.

The specimen should then be tested immediately. If the specimens are allowed to remain out of water for even a short time before testing, they dry out to a greater or lesser extent and the test is likely to be misleading.

Where necessary, a small amount of varnish is removed from the copper foil to make contact so that the copper foil acts as the second electrode. Three panels are tested. The thickness measurements shall be made with a dial-type micrometer on each panel and at the same point after coating.

If prescribed in the specification, the test shall be conducted at different temperatures.

20.4 Results

The test report shall state:

a) identification of the varnish tested;

b) drying time and temperature;

c) conditioning method;

d) average steel thickness;

e) individual film thickness (half the individual overall thickness readings minus half the average copper thickness);

f) average film thickness;

g) individual breakdown voltages; dry and after immersion in water; and

h) average electric strength in kV/ m (average voltage breakdown divided by average film thickness, in micrometers).

21 RESISTANCE TO TRACKING

21.1 Scope and Definitions

This method of test is intended to indicate the relative behaviour of finishing varnishes with regard to their susceptibility to surface tracking when exposed, under electric stress, to an electrolyte.

The definitions are the same as those described in IS 10026 (Part 3).

21.2 Test Specimens

The substrate shall be a sheet of phenolic resin bonded paper laminate, 3 mm thick, of area not less than 60 mm 100 mm. The comparative tracking index of the substrate shall be in the range 130 to 140 V.

One surface, which shall be free from all scratches or blemishes, shall be coated with a uniform layer of the varnish to be tested, such that when dry or cured, the layer shall be 0.05 to 0.055 mm thick unless otherwise specified and free from bubbles, cracks or inclusions.

Other substrates may be relevant for specific evaluation of tracking resistance. These substrates are to be agreed upon between the purchaser and the supplier.

21.3 Test Apparatus

The test apparatus is the same as that described in IS 10026 (Part 3).

21.4 Procedure

The test shall be carried out at an ambient temperature of 22 to 32°C; the material of the test electrodes shall be platinum.

21.4.1 To determine whether the varnish decreases the resistance to tracking (Method A).

Five specimens, not less than 15 mm 15 mm and without damage to the varnish layer, shall be cut from the test piece and tested with the voltage applied to the electrodes set at 130 V. The number of drops to failure shall be recorded and the central of the five values taken as result.

If the mean value is 50 or less, the varnish shall be reported as decreasing the resistance to tracking.

If the central value exceeds 50, Method B may be followed.

21.4.2 To determine the degree of protection provided by the varnish (Method B) five specimens, not less than 15 mm 15 mm and without damage to the varnish layer, shall be cut from the test piece and tested with the voltage applied to the electrodes set at 200 V.

The number of drops to failure shall be recorded and the central of the five values reported.

21.5 Test Report

The test report shall state:

a) identification of the varnish tested;
b) thickness of the varnish;
c) temperature and time of curing or drying of the varnish;
d) number of drops according to Method A;
e) number of drops according to Method B; and
f) the fact that the varnish decreases or increases tracking, as appropriate.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
101 : 1964	Methods of test for ready mixed paints and enamals (*second revision*)
101(Part 2/Sec 2) : 1986	Methods of sampling and test for paints, varnishes and related products: Part 2 Test on liquid paints (chemical examination), Section 2 Volatile matter (*third revision*)
197 : 1969	Methods of sampling and test for varnishes and lacquers (*first revision*)
513 : 1973	Cold-rolled low carbon steel sheets and strips (*third revision*)
2584 : 1963	Method of test for electric strength of solid (*third revision*)
3396 : 1979	Methods of test for volume and surface resistivity of electrical insulating materials (*first revision*)
3944 : 1982	Method of determination of flow time by use of flow cups (*first revision*)
10026 (Part 3) : 1983	Insulating varnishes containing solvents: Part 3 Specifcations for individual materials
10175 : 1982	Modified Erichsen cupping test for metallic sheet and strip
1373 (Part 0/Sec 1) : 1993	Particular types of winding wires: Part 0 General requirements, Section 1 Enamelled round copper wire

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